

WHAT IS CLAIMED IS:

1 1. A wind turbine apparatus comprising:
2 a conduit extending along a longitudinal axis of the apparatus, the conduit comprising
3 an inlet portion at a first end of the longitudinal axis, the inlet portion having a
4 main inlet opening,
5 an outlet portion at a second end of the longitudinal axis, the outlet portion having
6 a main outlet opening, and
7 a middle portion located between the inlet and outlet portions, the inlet portion
8 being fluidly connected to the outlet portion via the middle portion;
9 a rotor located in the middle portion of the conduit, the rotor comprising
10 a shaft extending along a rotational axis through the middle conduit portion, the
11 rotor being adapted to rotate about the rotational axis, wherein the longitudinal axis intersects the
12 rotational axis, wherein a rotor angle formed between the longitudinal axis and the rotational axis
13 is between about 45 degrees and about 135 degrees, and wherein a longitudinal angle formed
14 between the longitudinal axis and an overall wind flow direction for wind flowing through the
15 conduit when the apparatus is being powered by a wind flow is less than about 45 degrees, and
16 blades extending from the shaft, the blades being located completely within the
17 middle portion of the conduit;
18 a splitter located in the inlet portion of the conduit, so that the inlet portion of the conduit
19 comprises an upper sub-tunnel and a lower sub-tunnel divided by the splitter, wherein the upper
20 and lower sub-tunnels both feed into a middle portion inlet of the middle portion of the conduit,
21 wherein the middle portion inlet is closer to the main inlet opening than a middle portion outlet
22 of the middle portion along the longitudinal axis, and wherein the middle portion outlet is closer

23 to the main outlet opening than the middle portion inlet along the longitudinal axis;
24 an upper interior wall of the middle conduit portion having a substantially circular plane
25 shape that is substantially centered at the rotational axis, wherein an upper clearance gap is
26 located between the blades and the upper interior wall of the middle conduit portion when the
27 blades pass thereby; and
28 a lower interior wall of the middle conduit portion having a substantially circular plane
29 shape that is substantially centered at the rotational axis, the lower interior wall of the middle
30 conduit portion being opposite and facing the upper interior wall of the middle conduit portion,
31 wherein a lower clearance gap is located between the blades and the lower interior wall of the
32 middle conduit portion when the blades pass thereby, and wherein side clearance gaps are
33 located between sides of the blades and the middle conduit portion.

1 2. The wind turbine apparatus of claim 1, wherein the splitter is generally wedge-shaped
2 with a smaller leading end thereof located closer to the main inlet opening than a larger trailing
3 end thereof.

1 3. The wind turbine apparatus of claim 2, wherein an upper inlet cross-section area for an
2 upper inlet of the upper sub-tunnel is larger than an upper outlet cross-section area for an upper
3 outlet of the upper sub-tunnel, the upper inlet of the upper sub-tunnel being located closer to the
4 main inlet opening of the inlet portion than the upper outlet of the upper sub-tunnel, and
5 wherein a lower inlet cross-section area for a lower inlet of the lower sub-tunnel is
6 larger than a lower outlet cross-section area for a lower outlet of the lower sub-tunnel, the lower
7 inlet of the lower sub-tunnel being located closer to the main inlet opening of the inlet portion
8 than the lower outlet of the lower sub-tunnel, and

9 wherein the upper and lower outlets of the upper and lower sub-tunnels both feed
10 into the middle portion of the conduit.

1 4. The wind turbine apparatus of claim 3, wherein a size of the upper inlet cross-section area
2 is between about 19% and about 35% of the lower inlet cross-section area.

1 5. The wind turbine apparatus of claim 1, wherein the rotor has a number of blades selected
2 from a group consisting of two, three, four, five, six, seven, and eight.

1 6. The wind turbine apparatus of claim 1, wherein the upper clearance gap is less than about
2 10 mm.

1 7. The wind turbine apparatus of claim 1, wherein the lower clearance gap is less than about
2 10 mm.

1 8. The wind turbine apparatus of claim 1, further comprising an outlet centroid of a main
2 outlet cross-section area for the main outlet opening being located higher than an inlet centroid
3 of a main inlet cross-section area for the main inlet opening relative to the rotational axis and
4 relative to the longitudinal axis.

1 9. The wind turbine apparatus of claim 8, wherein the main outlet cross-section area is
2 about equal to the main inlet cross-section area.

1 10. The wind turbine apparatus of claim 1, further comprising:
2 a first electric power generator located outside of a first side of the conduit and
3 rotationally coupled to a first end of the shaft, wherein a first generator rotor of the first electric

4 power generator is adapted to rotate about the rotational axis; and
5 a second electric power generator located outside of a second side of the conduit and
6 rotationally coupled to a second end of the shaft, wherein a second generator rotor of the second
7 electric power generator is adapted to rotate about the rotational axis.

1 11. The wind turbine apparatus of claim 1, wherein an outer top surface section of the outlet
2 conduit portion is substantially parallel with the longitudinal axis, the outer top surface section
3 having a substantially flat planar shape, and the outer top surface section being proximate to the
4 main outlet opening.

1 12. The wind turbine apparatus of claim 1, wherein an outer bottom surface section of the
2 outlet conduit portion is substantially parallel with the longitudinal axis, the outer bottom surface
3 section having a substantially flat planar shape, and the outer bottom surface section being
4 proximate to the main outlet opening.

1 13. The wind turbine apparatus of claim 1, wherein outer side surfaces of the conduit have a
2 substantially flat planar shape and are substantially parallel with the longitudinal axis.

1 14. The wind turbine apparatus of claim 1, wherein an outer top surface section of the inlet
2 conduit portion is substantially parallel with the longitudinal axis, the outer top surface section
3 having a substantially flat planar shape, and the outer top surface section being proximate to the
4 main inlet opening.

1 15. The wind turbine apparatus of claim 1, wherein an inner bottom surface inlet angle is
2 formed between an inner bottom surface section of the inlet conduit portion and the longitudinal

3 axis, the inner bottom surface inlet angle being an acute angle, the inner bottom surface section
4 having a substantially flat planar shape, and the inner bottom surface section being proximate to
5 the main inlet opening.

1 16. The wind turbine apparatus of claim 1, wherein an inner top surface outlet angle is
2 formed between an inner top surface section of the outlet conduit portion and the longitudinal
3 axis, the inner top surface outlet angle being an acute angle, the inner top surface section having
4 a substantially flat planar shape, and the inner top surface section being proximate to the middle
5 conduit portion.

1 17. The wind turbine apparatus of claim 16, wherein the inner top surface outlet angle is
2 between about 26 degrees and about 39 degrees.

1 18. The wind turbine apparatus of claim 1, wherein a middle portion outlet cross-section area
2 for a middle portion outlet of the middle conduit portion is smaller than the main outlet cross-
3 section area for the main outlet opening.

1 19. The wind turbine apparatus of claim 18, wherein an inner bottom surface outlet angle is
2 formed between an inner bottom surface section of the outlet conduit portion and the longitudinal
3 axis, the inner bottom surface outlet angle being an acute angle.

1 20. The wind turbine apparatus of claim 19, wherein a curved transition section is located at
2 the middle portion outlet and connects between the inner bottom surface section of the outlet
3 conduit portion and the lower interior wall of the middle conduit portion.

1 21. The wind turbine apparatus of claim 1, further comprising:
2 a first support stand portion attached to the conduit; and
3 a second support stand portion pivotably coupled to the first support stand portion, the
4 first support stand portion being adapted to pivot about a vertical axis relative to the second
5 support stand portion.

1 22. The wind turbine apparatus of claim 1, wherein the inlet conduit portion has a first length
2 along the longitudinal axis, the outlet conduit portion has a second length along the longitudinal
3 axis, and the middle conduit portion has a third length along the longitudinal axis, wherein the
4 first length is about equal to the second length, and wherein the third length is about two times
5 that of the first length.

1 23. The wind turbine apparatus of claim 1, wherein an inner top surface section of the outlet
2 conduit portion is substantially parallel with the longitudinal axis, the inner top surface section
3 having a substantially flat planar shape, and the inner top surface section being proximate to the
4 main outlet opening; and
5 wherein an inner bottom surface section of the outlet conduit portion is substantially
6 parallel with the longitudinal axis and the inner top surface section, the inner bottom surface
7 section having a substantially flat planar shape, and the inner bottom surface section being
8 proximate to the main outlet opening.

1 24. The wind turbine apparatus of claim 1, wherein the longitudinal angle is about zero
2 degrees and the rotor angle is about 90 degrees.

1 25. The wind turbine apparatus of claim 1, wherein the side clearance gaps, the upper
2 clearance gap, and the lower clearance gap are about the same size.

1 26. The wind turbine apparatus of claim 1, wherein the side clearance gaps are each less than
2 about 10 mm.

27. A wind turbine apparatus comprising:

a conduit extending along a generally horizontal longitudinal axis of the apparatus, the conduit comprising

an inlet portion at a first end of the longitudinal axis, the inlet portion having a main inlet opening,

an outlet portion at a second end of the longitudinal axis, the outlet portion having a main outlet opening, and

a middle portion located between the inlet and outlet portions, the inlet portion being fluidly connected to the outlet portion via the middle portion;

a rotor located in the middle portion of the conduit, the rotor comprising

a shaft extending along a rotational axis through the middle conduit portion, the rotor being adapted to rotate about the rotational axis, wherein the longitudinal axis intersects the rotational axis, wherein a rotor angle formed between the longitudinal axis and the rotational axis is between about 45 degrees and about 135 degrees, and wherein a longitudinal angle formed between the longitudinal axis and an overall wind flow direction for wind flowing through the conduit when the apparatus is being powered by a wind flow is less than about 45 degrees, and

blades extending from the shaft, the blades being located completely within the middle portion of the conduit;

a splitter located in the inlet portion of the conduit, so that the inlet portion of the conduit comprises an upper sub-tunnel and a lower sub-tunnel divided by the splitter, the splitter being generally wedge-shaped with a smaller leading end thereof located closer to the main inlet opening than a larger trailing end thereof,

wherein an upper inlet cross-section area for an upper inlet of the upper

24 sub-tunnel is larger than an upper outlet cross-section area for an upper outlet of the upper
25 sub-tunnel, the upper inlet of the upper sub-tunnel being located closer to the main inlet opening
26 of the inlet portion than the upper outlet of the upper sub-tunnel,
27 wherein a lower inlet cross-section area for a lower inlet of the lower sub-tunnel is
28 larger than a lower outlet cross-section area for a lower outlet of the lower sub-tunnel, the lower
29 inlet of the lower sub-tunnel being located closer to the main inlet opening of the inlet portion
30 than the lower outlet of the lower sub-tunnel, and
31 wherein the upper and lower outlets of the upper and lower sub-tunnels both feed
32 into a middle portion inlet of the middle portion of the conduit, wherein the middle portion inlet
33 is closer to the main inlet opening than a middle portion outlet of the middle portion along the
34 longitudinal axis, and wherein the middle portion outlet is closer to the main outlet opening than
35 the middle portion inlet along the longitudinal axis;
36 an upper interior wall of the middle conduit portion having a substantially circular plane
37 shape that is substantially centered at the rotational axis, wherein an upper clearance gap is
38 located between the blades and the upper interior wall of the middle conduit portion when the
39 blades pass thereby;
40 a lower interior wall of the middle conduit portion having a substantially circular plane
41 shape that is substantially centered at the rotational axis, the lower interior wall of the middle
42 conduit portion being opposite and facing the upper interior wall of the middle conduit portion,
43 wherein a lower clearance gap is located between the blades and the lower interior wall of the
44 middle conduit portion when the blades pass thereby, and wherein side clearance gaps are
45 located between sides of the blades and the middle conduit portion; and
46 an outlet centroid of a main outlet cross-section area for the main outlet opening being

- 47 located higher than an inlet centroid of a main inlet cross-section area for the main inlet opening
- 48 relative to the rotational axis and relative to the longitudinal axis.

1 28. A wind turbine apparatus comprising:
2 a conduit extending along a generally horizontal longitudinal axis of the apparatus, the
3 conduit comprising
4 an inlet portion at a first end of the longitudinal axis, the inlet portion having a
5 main inlet opening,
6 an outlet portion at a second end of the longitudinal axis, the outlet portion having
7 a main outlet opening, and
8 a middle portion located between the inlet and outlet portions, the inlet portion
9 being fluidly connected to the outlet portion via the middle portion;
10 a rotor located in the middle portion of the conduit, the rotor comprising
11 a shaft extending along a rotational axis through the middle conduit portion, the
12 rotor being adapted to rotate about the rotational axis, wherein the longitudinal axis intersects the
13 rotational axis, wherein a rotor angle formed between the longitudinal axis and the rotational axis
14 is between about 45 degrees and about 135 degrees, and wherein a longitudinal angle formed
15 between the longitudinal axis and an overall wind flow direction for wind flowing through the
16 conduit when the apparatus is being powered by a wind flow is less than about 45 degrees, and
17 blades extending from the shaft, the blades being located completely within the
18 middle portion of the conduit;
19 a splitter located in the inlet portion of the conduit, so that the inlet portion of the conduit
20 comprises an upper sub-tunnel and a lower sub-tunnel divided by the splitter, the splitter being
21 generally wedge-shaped with a smaller leading end thereof located closer to the main inlet
22 opening than a larger trailing end thereof,
23 wherein an upper inlet cross-section area for an upper inlet of the upper

24 sub-tunnel is larger than an upper outlet cross-section area for an upper outlet of the upper
25 sub-tunnel, the upper inlet of the upper sub-tunnel being located closer to the main inlet opening
26 of the inlet portion than the upper outlet of the upper sub-tunnel,
27 wherein a lower inlet cross-section area for a lower inlet of the lower sub-tunnel is
28 larger than a lower outlet cross-section area for a lower outlet of the lower sub-tunnel, the lower
29 inlet of the lower sub-tunnel being located closer to the main inlet opening of the inlet portion
30 than the lower outlet of the lower sub-tunnel, and
31 wherein the upper and lower outlets of the upper and lower sub-tunnels both feed
32 into a middle portion inlet of the middle portion of the conduit, wherein the middle portion inlet
33 is closer to the main inlet opening than a middle portion outlet of the middle portion along the
34 longitudinal axis, and wherein the middle portion outlet is closer to the main outlet opening than
35 the middle portion inlet along the longitudinal axis;
36 an upper interior wall of the middle conduit portion having a substantially circular plane
37 shape that is substantially centered at the rotational axis, wherein an upper clearance gap is
38 located between the blades and the upper interior wall of the middle conduit portion when the
39 blades pass thereby;
40 a lower interior wall of the middle conduit portion having a substantially circular plane
41 shape that is substantially centered at the rotational axis, the lower interior wall of the middle
42 conduit portion being opposite and facing the upper interior wall of the middle conduit portion,
43 wherein a lower clearance gap is located between the blades and the lower interior wall of the
44 middle conduit portion when the blades pass thereby, and wherein side clearance gaps are
45 located between sides of the blades and the middle conduit portion;
46 an outlet centroid of a main outlet cross-section area for the main outlet opening being

47 located higher than an inlet centroid of a main inlet cross-section area for the main inlet opening
48 relative to the rotational axis and relative to the longitudinal axis;
49 a first electric power generator located outside of a first side of the conduit and
50 rotationally coupled to a first end of the shaft, wherein a first generator rotor of the first electric
51 power generator is adapted to rotate about the rotational axis; and
52 a second electric power generator located outside of a second side of the conduit and
53 rotationally coupled to a second end of the shaft, wherein a second generator rotor of the second
54 electric power generator is adapted to rotate about the rotational axis.

29. A wind turbine apparatus comprising:

a conduit extending along a longitudinal axis of the apparatus, the conduit comprising

an inlet portion at a first end of the longitudinal axis, the inlet portion having a

main inlet opening,

an outlet portion at a second end of the longitudinal axis, the outlet portion having

a main outlet opening, and

a middle portion located between the inlet and outlet portions, the inlet portion

being fluidly connected to the outlet portion via the middle portion;

a rotor located in the middle portion of the conduit, the rotor comprising

a shaft extending along a rotational axis through the middle conduit portion, the

rotor being adapted to rotate about the rotational axis, wherein the longitudinal axis intersects the

rotational axis, wherein a rotor angle formed between the longitudinal axis and the rotational axis

is between about 45 degrees and about 135 degrees, and wherein a longitudinal angle formed

between the longitudinal axis and an overall wind flow direction for wind flowing through the

conduit when the apparatus is being powered by a wind flow is less than about 45 degrees, and

blades extending from the shaft, the blades being located completely within the

middle portion of the conduit;

an upper interior wall of the middle conduit portion having a substantially circular plane

shape that is substantially centered at the rotational axis, wherein an upper clearance gap is

located between the blades and the upper interior wall of the middle conduit portion when the

blades pass thereby;

a lower interior wall of the middle conduit portion having a substantially circular plane

shape that is substantially centered at the rotational axis, the lower interior wall of the middle

24 conduit portion being opposite and facing the upper interior wall of the middle conduit portion,
25 wherein a lower clearance gap is located between the blades and the lower interior wall of the
26 middle conduit portion when the blades pass thereby;
27 a first electric power generator located outside of a first side of the conduit and
28 rotationally coupled to a first end of the shaft, wherein a first generator rotor of the first electric
29 power generator is adapted to rotate about the rotational axis; and
30 a second electric power generator located outside of a second side of the conduit and
31 rotationally coupled to a second end of the shaft, wherein a second generator rotor of the second
32 electric power generator is adapted to rotate about the rotational axis.

1 30. A wind turbine apparatus comprising:
2 a conduit extending along a longitudinal axis of the apparatus, the conduit comprising
3 an inlet portion at a first end of the longitudinal axis, the inlet portion having a
4 main inlet opening,
5 an outlet portion at a second end of the longitudinal axis, the outlet portion having
6 a main outlet opening, and
7 a middle portion located between the inlet and outlet portions, the inlet portion
8 being fluidly connected to the outlet portion via the middle portion;
9 a rotor located in the middle portion of the conduit, the rotor comprising
10 a shaft extending along a rotational axis through the middle conduit portion, the
11 rotor being adapted to rotate about the rotational axis, wherein the longitudinal axis intersects the
12 rotational axis, wherein a rotor angle formed between the longitudinal axis and the rotational axis
13 is between about 45 degrees and about 135 degrees, and wherein a longitudinal angle formed
14 between the longitudinal axis and an overall wind flow direction for wind flowing through the
15 conduit when the apparatus is being powered by a wind flow is less than about 45 degrees, and
16 blades extending from the shaft, the blades being located completely within the
17 middle portion of the conduit;
18 an upper interior wall of the middle conduit portion having a substantially circular plane
19 shape that is substantially centered at the rotational axis, wherein an upper clearance gap is
20 located between the blades and the upper interior wall of the middle conduit portion when the
21 blades pass thereby, wherein the upper clearance gap is less than about 10 mm; and
22 a lower interior wall of the middle conduit portion having a substantially circular plane
23 shape that is substantially centered at the rotational axis, the lower interior wall of the middle

24 conduit portion being opposite and facing the upper interior wall of the middle conduit portion,
25 wherein a lower clearance gap is located between the blades and the lower interior wall of the
26 middle conduit portion when the blades pass thereby, wherein the lower clearance gap is less
27 than about 10 mm, and wherein side clearance gaps of less than about 10 mm are located
28 between sides of the blades and the middle conduit portion.

1 31. The wind turbine apparatus of claim 30, wherein the rotor has a diameter of less than
2 about 2 meters, wherein the upper clearance gap is less than about 3 mm, wherein the lower
3 clearance gap is less than about 3 mm, and wherein each of the side clearance gaps is less than
4 about 3 mm.

1 32. The wind turbine apparatus of claim 30, wherein the rotor has a diameter of less than
2 about 3 meters, wherein the upper clearance gap is less than about 5 mm, wherein the lower
3 clearance gap is less than about 5 mm, and wherein each of the side clearance gaps is less than
4 about 5 mm.